

REMARKS

This is intended as a full and complete response to the Office Action dated June 13, 2005, having a shortened statutory period for response set to expire on September 13, 2005. Please reconsider the claims pending in the application for reasons discussed below.

Claims 1-7, 9-42, and 44-69 remain pending in the application and are shown above. Claims 1-7, 9-42, and 44-69 stand rejected. Claims 1, 11, 15, 23, 30, 42, and 47 are amended to clarify the invention. Reconsideration of the rejected claims is requested for reasons presented below.

Claim Rejections – 35 USC § 103

Claims 1-7, 9-31, 33-42, and 44-69 stand rejected under 35 USC § 103(a) as being obvious over *Lopatin et al.* (US Patent No. 6,368,954) in view of *Uzoh* (U.S. 6,126,806). Applicant respectfully traverses the rejection.

Lopatin et al. teaches a barrier layer of 20-300 angstroms formed by atomic layer deposition, a pre-seed layer comprising copper formed by atomic layer epitaxy, and a seed layer comprising copper formed by chemical vapor deposition (CVD). *Lopatin et al.* does not teach, show, or suggest a seed layer comprising copper and a metal selected from the group consisting of aluminum, magnesium, zirconium, and combinations thereof.

Uzoh teaches a composite copper film including a seed layer comprising copper and an additive of indium, tin, titanium, or chromium at a range of 0.01% to 5% atomic percentage, a bulk copper layer, and a laminated impurity layer comprising oxygen, carbon, sulfur, and nitrogen, such that the indium, tin, titanium, or chromium additive reacts with the laminated oxygen, carbon, sulfur, or nitrogen impurity layer after annealing the composite copper film to form into intermetallic compounds comprising indium oxides, tin oxides, copper indium oxide, copper tin oxide. (See, column 8, lines 8-13; column 8, lines 23-40.) Thus, *Uzoh* teaches reacting the indium, tin, titanium, or chromium additive with oxygen, carbon, sulfur, or nitrogen impurity in a bulk copper film and the final product of *Uzoh*'s copper film is copper containing indium oxides or copper

containing tin oxides such that the final copper containing indium oxides or copper containing tin oxides composite film is more resistance to mobility and suppress metal grain boundary growth as compared to a copper only film.

Claims 1, 11, 15, 23, and 30 have been amended to recite a seed layer comprising copper and a metal selected from the group consisting of aluminum, magnesium, zirconium, and combinations thereof. *Lopatin et al.* in view of *Uzoh* does not teach, show, or suggest depositing a seed layer on a barrier layer having a thickness less than about 50 Å, the seed layer comprising copper and a metal selected from the group consisting of aluminum, magnesium, zirconium, and combinations thereof, as recited in claims 1, 11, 15, 23, and 30, and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 42 and 47 have been amended to recite depositing a seed layer comprising copper and a metal selected from the group consisting of aluminum, magnesium, zirconium, and combinations thereof. *Lopatin et al.* in view of *Uzoh* does not teach, show, or suggest depositing a barrier layer by atomic layer deposition, the barrier layer having a thickness of less than about 20 Å, and then depositing a seed layer comprising copper and a metal selected from the group consisting of aluminum, magnesium, zirconium, and combinations thereof, as recited in claims 42 and 47 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 31-32, 42, and 44-69 stand rejected under 35 USC § 103(a) as being obvious over *Lopatin et al.* in view of *Uzoh et al.*, and in further view of *Tsai et al.* (US Patent No. 6,309,964). Applicant respectfully traverses the rejection.

Lopatin et al. and *Uzoh et al.* have been discussed above.

Tsai et al., as stated by the Examiner, discloses only a barrier layer of 10-500 angstroms. *Tsai et al.*, does not teach, show or suggest the subject matter as claimed in claims 31-32, 42, and 44-69 or any element lacking in *Lopatin et al.* and *Uzoh et al.*, as discussed above.

Claims 31-32 and 44-52 depend on claims 30, 42, and 47. Applicant has amended claims 30, 42, and 47 to recite depositing a seed layer comprising copper and a metal selected from the group consisting of aluminum, magnesium, zirconium, and combinations thereof. *Lopatin et al.* in view of *Uzoh*, and in further view of *Tsai et al.*

does not teach, show, or suggest depositing a barrier layer having a thickness less than about 20 Å, and then depositing a seed layer comprising copper and a metal selected from the group consisting of aluminum, magnesium, zirconium, and combinations thereof, as recited in claims 31-32 and 44-52. Withdrawal of the rejection is respectfully requested.

Regarding claims 53-58, none of the previously mentioned references in view of *Tsai et al.* teach, show, or suggest a first seed layer comprising aluminum. *Lopatin et al.* in view of *Uzoh*, and in further view of *Tsai et al.* does not teach, show, or suggest a method of filling a feature, comprising depositing a barrier layer by atomic layer deposition, the barrier layer having a thickness less than about 20 Å, depositing a first seed layer over the barrier layer to a sidewall coverage between a sub-monolayer and about 50 Å, the first seed layer comprising aluminum, depositing a second seed layer over the first seed layer, and depositing a conductive material layer over the second seed layer, as recited in claim 53 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Regarding claims 59-69, none of the previously mentioned references in view of *Tsai et al.* teach, show, or suggest a seed layer comprising copper and aluminum. *Lopatin et al.* in view of *Uzoh*, and in further view of *Tsai et al.* does not teach, show, or suggest a method of preparing a substrate structure for electroplating of copper, comprising depositing a barrier layer by atomic layer deposition, the barrier layer having a thickness less than about 20 Å, and depositing a seed layer over the barrier layer, the seed layer comprising copper and aluminum, as recited in claim 59 and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the invention as claimed.

Having addressed all issues set out in the office action, Applicant respectfully submits that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,



Keith M. Tackett
Registration No. 32,008
PATTERSON & SHERIDAN, L.L.P.
3040 Post Oak Blvd. Suite 1500
Houston, TX 77056
Telephone: (713) 623-4844
Facsimile: (713) 623-4846
Attorney for Applicant(s)